PHYS Lab on Spectra            Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Watch the following video and answer the questions below:

<https://www.youtube.com/watch?v=jjy-eqWM38g>

1. What is light?
2. How is the energy (E) of a photon of light related to its wavelength (λ)?
3. What are spectra (plural for spectrum)?
4. Expain the origin of light (or how light is produced)?
5. Wavelength of light emitted by a body depends on the body’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
6. Name three subatomic particles the atoms are made of?
7. What is the analogy used for quantization of electron energy in the video?
8. What is the key to the universe, according to the video?

1. Name the device that measures the wavelength of light?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. What is Doppler effect?
3. How do we know that the universe is expanding?

2. Energy levels of the electron of the hydrogen atom are shown below. Calculate and list the energy values, $E\_{n}=-\frac{13.6}{n^{2}}$ eV, with the orbitals.


A photon of light is emitted when the electron transitions to a lower energy. The wavelength (λ) of emitted light is given by:
 $∆E=\frac{hc}{λ}$; h = 6.626x10-34J.s and c = 2.998x108m/s. 1eV=1.602x10-19J

a. What is the SI unit for the product, *hc*?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b. Calculate the value of *hc*, in the unit eV.nm, and enter it for e on the next page.

c. Calculate the 4 of the highest wavelengths (λ) of the Balmer series in nm, and enter them in the data table on page 4.

3. Visit this simulation: <https://javalab.org/en/spectrum_of_hydrogen_en/>

a. The simulation shows the light emission for the hydrogen atom. Make a note of the wavelength (λ), energy difference (ΔE), and energy levels involved for the light emitted.

λ = \_\_\_\_\_\_\_\_\_\_\_\_$\left|∆E\right|$ = \_\_\_\_\_\_\_\_\_\_\_\_Energy levels (E1, E2, etc) involved =\_\_\_\_\_\_\_\_\_

b. To find out the transitions to which electron orbit will result in the visible spectra:

|  |  |  |  |
| --- | --- | --- | --- |
| Move Electron to get transition: | Wavelength (nm) |  $\left|∆E\right|$ (eV) | Visible (Yes or No) |
| E2 🡪 E1 |  |  |  |
| E3 🡪 E1 |  |  |  |
| E4 🡪 E1 |  |  |  |
| E5 🡪 E1 |  |  |  |
| E6 🡪 E1 |  |  |  |
| E7 🡪 E1 |  |  |  |
| E8 🡪 E1 |  |  |  |
| Move Electron to get transition: | Wavelength (nm) |  $\left|∆E\right|$ (eV) | Visible (Yes or No) |
| E3 🡪 E2 |  |  |  |
| E4 🡪 E2 |  |  |  |
| E5 🡪 E2 |  |  |  |
| E6 🡪 E2 |  |  |  |
| E7 🡪 E2 |  |  |  |
| E8 🡪 E2 |  |  |  |
| E9 🡪 E2 |  |  |  |
| Move Electron to get transition: | Wavelength (nm) |  $\left|∆E\right|$ (eV) | Visible (Yes or No) |
| E4 🡪 E3 |  |  |  |
| E5 🡪 E3 |  |  |  |
| E6 🡪 E3 |  |  |  |
| E7 🡪 E3 |  |  |  |
| E8 🡪 E3 |  |  |  |
| E9 🡪 E3 |  |  |  |

c. Go to Excel, and enter the wavelength, λ and absolute values of ΔE, $\left|∆E\right|$ values. Also insert a column after the first column, and calculate 1/λ.

d. Plot $\left|∆E\right|$ versus 1/λ, determine the slope with unit. Slope = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

e. What is the theoretical value for the slope in the same unit?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

f. Calculate the % difference for the above two values\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. Measuring the wavelengths using the Ocean Optics spectrometer:
Calibration:
a. Open the Ocean Optics program (OOIBase32, from desktop).
b. Point the fiber optic cable to the laser beam from the diode laser (λ = 650 nm).
c. Adjust the position of the cable-head to obtain a sharp peak and Click on the Global Snapshot button (3rd from top-left) to get a snap shot.
d. Click on the Toggle Cursor BUTTON (1st on right-top) to display the green vertical line (curser), line up the peak with the curser, and record the wavelength (bottom-left corner).
e. Difference between the above value and 650 nm will be the correction.\_\_\_\_\_\_\_\_\_\_\_

Data for Balmer series of the H-spectrum:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Transition from | λ, calculated | λ, measured(OOIBase32) | λ, corrected | %Difference | Intensity Count |
| 3rd electron orbit to 2nd  |  |  |  |  |  |
| 4th electron orbit to 2nd |  |  |  |  |  |
| 5th electron orbit to 2nd |  |  |  |  |  |
| 6th electron orbit 2nd |  |  |  |  |  |

a. Set up the fiber optic cable next to the hydrogen spectrum tube and turn on the tube.

b. Open the Ocean Optics program (OOIBase32, from desktop).

c. Click on the Toggle Cursor BUTTON (1st on right-top) to display the green vertical line (curser).

d. Click on a peak to move the cursor over the peak, use the arrow keys to align the cursor over the peak. Wavelength and intensity are read from the bottom-left corner.

e. Measure the wavelengths for the lines you observe. Record the measured values in the above data table, and calculate the %difference.

f. Adjust the position of the cable-head so that the intensity of the highest peak is close to the maximum count.

g. Click on the Global Snapshot button (3rd from top-left) and record the intensity counts for all the peaks.

5. Replace the hydrogen tube with the helium tube. Adjust the position of the cable-head so that the intensity of the highest peak is close to the maximum count.
Record the wavelengths and intensity counts for all the peaks of the helium spectrum.
DATA for He-spectrum:

|  |  |  |
| --- | --- | --- |
| Wavelength of the line from OOIBase32 | Corrected Wavelength | Intensity count of the line |
|   |  |   |
|   |  |   |
|   |  |   |
|   |  |   |
|   |  |   |
|   |  |   |
|   |  |   |
|   |  |   |
|   |  |   |

6. Fluorescent light spectrum: Identifying peaks and measuring wavelength.
[http://en.wikipedia.org/wiki/File:Fluorescent\_lighting\_spectrum\_peaks\_labelled.gif](http://en.wikipedia.org/wiki/File%3AFluorescent_lighting_spectrum_peaks_labelled.gif)
Aim the fiber-optic cable at the ceiling light fixture, observe the spectrum of the fluorescent light bulb, and complete the following data table.

|  |  |
| --- | --- |
| Peak Number | Wavelength of Peak (nm) |
| From wikipedia | Measured (OOIBase32) | Corrected Wavelength |
| 1 | 405.4 |  |  |
| 2 | 436.6 |  |  |
| 3 | 487.7 |  |  |
| 4 | 542.4 |  |  |
| 5 | 546.5 |  |  |
| 6 | 577.7 |  |  |
| 7 | 580.2 |  |  |
| 8 | 584.0 |  |  |
| 9 | 587.6 |  |  |
| 10 | 593.4 |  |  |
| 11 | 599.7 |  |  |
| 12 | 611.6 |  |  |
| 13 | 625.7 |  |  |
| 14 | 631.1 |  |  |
| 15 | 650.8 |  |  |
| 16 | 662.6 |  |  |
| 17 | 687.7 |  |  |
| 18 | 693.7 |  |  |
| 19 | 708 |  |  |
| 20 | 712.3 |  |  |
| 21 | 760.0 |  |  |